[DOCUMENT NAME] SPECIFICATION

[TITLE OF THE INVENTION] AIR-CONDITIONING APPARATUS

[WHAT IS CLAIMED IS:]

[Claim 1] An air-conditioning apparatus comprising:

an air-conditioning case (30) forming an air passage;

a cooling heat exchanger (21) for cooling air passing therethrough, said cooling heat exchanger (21) being disposed in said air-conditioning case (30) to have an inclined air ventilation surface and to form a lower space (50) below said cooling heat exchanger, in such a manner that air passes through said cooling heat exchanger (21) upwardly from a lower side thereof; and

a drain guide member (33b) disposed in said lower space (50) of said cooling heat exchanger (21) to approximately contact an inclination lower end side of said cooling heat exchanger (21);

wherein condensed water generated in said cooling heat exchanger (21) flows from an inclination upper end side of said cooling heat exchanger (21) toward an inclination lower end side thereof, and thereafter is guided to a bottom surface (30a) of said air-conditioning case (30) along outside surface of said drain guide member (33b),

said air-conditioning apparatus characterized in that:

a plate-like member (33a) is disposed in said lower space (50) within said air-conditioning case (30) at said inclination upper end side from said drain guide member (33b); and

said plate-like member (33a) continuously extends in an

arrangement direction of said drain guide member (33b) to cover said drain guide member (33b).

[Claim 2] An air-conditioning apparatus according to claim 1, characterized in that:

in said air-conditioning case (30), there is formed a drain passage (60) for leading the condensed water, dripped at said inclined upper end side from said plate-like member (33a), to a side of said drain guide member (33b); and

said drain passage (60) is formed by a lower end portion (36 and 42) of said plate-like member (33a) and said bottom surface (30a) of said air-conditioning case (30).

[Claim 3] An air-conditioning apparatus according to claim 1, characterized in that said plate-like member (33a) and said drain guide member (33b) are integrally formed.

[Claim 4] An air-conditioning apparatus according to any one of claims 1 to 3, characterized in that said plate-like member (33a) is disposed to separate said lower space (50) into an air-blown space (50a) on an inclination upper end side, in which air flows, and a drain space (50b) on said inclination lower end side from said air-blown space (50a), for guiding the condensed water.

[Claim 5] An air-conditioning apparatus according to claim 4, characterized in that said drain guide member (33b) is provided, at the upper end, with a draining elastic portion (38) which is elastically deformed to contact an inclination lower end portion (32) of said cooling heat exchanger (21).

[Claim 6] An air-conditioning apparatus according to claim

4 or 5, characterized in that said plate-like member (33a) is provided, at the upper end (37), with a partitioning elastic portion (37) elastically deformed to contact an inclination lower end portion (32) of said cooling heat exchanger (21).

[Claim 7] An air-conditioning apparatus according to any one of claim 1 to 6, characterized in that:

said cooling heat exchanger (21) has an air-cooling portion (21h) formed by a plurality of laminated tubes (21f) in which refrigerant flows;

on at least one end side of said cooling heat exchanger (21), there is formed a tank portion (21e) where refrigerant is distributed to said tubes (21f) or the refrigerant from said tubes (21f) joins; and

said cooling heat exchanger (21) is disposed in said air-conditioning case (30) in such a manner that said tank portion (21e) is positioned on said inclination lower end side and said drain guide member (33b) is disposed to nearly contact a lower surface of said tank portion (21e).

[Claim 8] An air-conditioning apparatus according to claim 7, characterized in that an upper end portion (37) of said plate-like member (33a) is disposed to be nearly adjacent to a boundary between said air cooling portion (21h) and said tank portion (21e).

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Industrial Field of Utilization]

The present invention relates to an air-conditioning

apparatus and, more particularly, to an air-conditioning apparatus in which a cooling heat exchanger is inclined so that air flows upwardly from below in the cooling heat exchanger.

[0002]

[Prior Art]

In a prior art air-conditioning apparatus for a vehicle, an evaporator (cooling heat exchanger) is inclined in an attempt to build an air-conditioning unit in a compact configuration to thereby allow the flow of air upwardly from below in the evaporator (Japanese Patent Laid-Open No. Hei 8-104129). In this prior art apparatus, a plurality of drain guide plates are provided nearly adjacently to the lower part of the lower end portion of inclination of the evaporator, that is, to the outside surface of the core portion where heat-exchange is performed between the air and the refrigerant, thereby to improve drain performance of the condensed water generated on the evaporator.

[0003]

The condensed water in the evaporator is usually generated from the whole body of the evaporator. In the prior art apparatus, because the air-conditioning air flows upwardly from below in the evaporator, condensed water does not directly drop with its own weight, but flows down along the surface of the evaporator, gathering at the lower end portion of inclination, and thereafter running down on the surface of the drain guide plate and being discharged out of the motor vehicle.

[0004]

Furthermore, in the prior art apparatus, the drain guide plate is cross-shaped to make it hard to form an upward air stream on the back side of the drain guide plate, thereby facilitating dripping of the condensed water from the lower end portion of inclination.

[0005]

[Problem to Be Solved by the Invention]

According to the inventor's investigation, however, such a problem has been found that because a plurality of drain guide plates stated above are arranged at spaces, the upward stream of air-conditioning air hits on the lower end portion of inclination and condensed water formed on the lower end portion of inclination is blown upwardly with the pressure of air-conditioning air, deteriorating the draining efficiency and consequently causing the condensed water to be blown off.

[0006]

It is, therefore, a first object of the present invention to provide an air-conditioning apparatus in which the cooling heat exchanger is disposed to be inclined and to allow upward flow of air in the cooling heat exchanger, thereby improving drain-performance of condensed water in the cooling heat exchanger.

[0007]

[Means for Solving the Problem]

To achieve the first object, the air-conditioning apparatus as defined in claims 1 to 8 of the present invention

is characterized by the provision of a plate-like member (33a) disposed on the inclination upper end side above a drain guide member (33b), in a lower space (50) within an air-conditioning case (30); the plate-like member (33a) continuously extending in an arrangement direction of the drain guide member (33b) so as to cover the drain guide member (33b).

[0008]

Because the plate-like member continuously extends in the arrangement direction of the drain guide member to cover the drain guide member, it becomes hard, as compared with the prior art apparatus, that air hits against the inclination lower end side of the cooling heat exchanger where the condensed water gathers. Therefore, the condensed water that has been gathered on the inclination lower end side of the cooling heat exchanger can drip fast without being affected by air flow. Consequently, it is possible to drain the condensed water more effectively.

[0009]

Furthermore, in the air-conditioning apparatus as defined in claim 2 of the present invention, the air-conditioning case (30) has a drain passage (60) through which condensed water, dripped to the inclination upper end side from the plate-like member (33a), to a side of said drain guide member, and the drain passage (60) is formed by the lower end portions (36 and 42) of the plate-like member (33a) and a bottom surface (30a) of the air-conditioning case (30).

[0010]

Thus, condensed water dripped to the inclination upper end side from the plate-like member is introduced to a side of the drain guide member through the drain passage, and can be guided smoothly to the bottom surface of the air-conditioning case.

In this drain passage, a little quantity of air flows. The drain passage mentioned here is meant by a passage in which draining of the condensed water is not adversely be affected by the flow of the air.

[0011]

The air-conditioning apparatus as defined in claim 3 of the present invention is characterized in that the plate-like member (33a) and the drain guide member (33b) are integrally molded.

Because the plate-like member and the drain guide member are integrally formed, assembling performance of the plate-like member and the drain guide member can be improved.

Furthermore, the air-conditioning apparatus as defined in claim 4 of the present invention is characterized in that the plate-like member (33a) separates the lower space (50) into an air-blown space (50a) through which air flows, at the inclination upper end side, and a drain space (50b), at the inclination lower end side from the air-blown space (50b), to which the condensed water is guided.

Because the lower space is separated by the plate-like member into the air-blown space and the drain space, it has become possible to reliably prevent the air from hitting on the

inclination lower end side of the cooling heat exchanger, where the condensed water gathers. Therefore, the condensed water that has gathered at the inclination lower end side of the cooling heat exchanger drips fast to the bottom surface absolutely without being affected by air. As a result, the condensed water can be drain with a higher efficiency.

[0012]

Furthermore, the air-conditioning apparatus as defined in claim 5 of the present invention is characterized in that said drain guide member (33b) is provided, at the upper end, with a draining elastic portion (38) which is elastically deformed to contact an inclination lower end portion (32) of said cooling heat exchanger (21).

Thus, it becomes possible to properly guide the condensed water to the bottom surface notwithstanding an assembling error of the cooling heat exchanger and a fabrication tolerance of the cooling heat exchanger itself, by elastically deforming the draining elastic portion to contact the inclination lower end portion of the cooling heat exchanger.

[0013]

Furthermore, the air-conditioning apparatus as defined in claim 6 of the present invention is characterized in that: at an upper end portion (37) of the plate-like member (33a), there is formed a partitioning elastic portion (37) which is elastically deformed to contact the inclination lower end portion (32).

The partitioning elastic portion, being elastically

deformed to contact the cooling heat exchanger, can function as a seal, thereby to fully prevent the air-conditioning air from hitting on the inclination lower end portion. Consequently, the condensed water that is gathered at the inclination lower end portion of the cooling heat exchanger can drip faster to the bottom surface, thereby further improving draining efficiency of the condensed water.

[0014]

Furthermore, the air-conditioning apparatus as defined in claim 7 of the present invention is characterized in that the cooling heat exchanger (21) includes an air cooling portion (21h) having a plurality of laminated tubes (21f) in which refrigerant flows. On at least one end side of the cooling heat exchanger (21), there is formed a tank portion (21e) where refrigerant is distributed to the tubes (21f) or the refrigerant from the tubes (21f) joins. The cooling heat exchanger (21) is disposed within the air-conditioning case (30) so that the tank portion is located on a side of the inclination lower end portion (32), and the drain guide member (33b) is arranged to approximately contact a lower surface of the tank portion (21e).

[0015]

According to the investigation of the inventors of the present invention, it was found that: since the tank portion has a specially complicated outside configuration, the condensed water will not smoothly gather at the inclination lower end portion similarly to the prior art apparatus, and

accordingly will not be discharged to be easily blown off.

In the air-conditioning apparatus as defined in claim 7 of the present invention, the condensed water can be drained particularly effectively.

[0016]

Furthermore, the air-conditioning apparatus as defined in claim 8 of the present invention is characterized in that the upper end portion (37) of the plate-like member (33a) is disposed in the vicinity of the boundary between the air cooling portion (21h) and the tank portion (21e).

Thus, it is possible to prevent air from hitting against the tank portion and the plate-like member from reducing the quantity of air passing through the air cooling portion. Thus, draining efficiency of the condensed water can be improved without deteriorating the cooling performance in the cooling heat exchanger.

[0017]

[Preferred Embodiment]

A preferred embodiment of an air-conditioning apparatus according to the present invention will hereinafter be described with reference to the accompanying drawings.

In FIGS. 1 and 2, an engine compartment A and a passenger compartment B are separated by a partition plate C (generally called a fire wall produced of an iron plate). A blower unit 1 of the air-conditioning apparatus is mounted offset in a width direction of the vehicle from a central part of an instrument panel P in the passenger compartment B (offset to

the left side in the width direction of the vehicle in a right-hand drive motor vehicle).

[0018]

The blower unit 1 has an inside-outside air changeover box 11 in an upper part, for changing over between the inside air (i.e., air inside the passenger compartment) and the outside air (i.e., air outside the passenger compartment) to be introduced therein. The inside-outside air changeover box 11 is provided with an outside air inlet 12 and an inside air inlet 13, in which an unillustrated inside-outside air changeover door is mounted for opening and closing these inlets 12 and 13.

Under the inside-outside air changeover box 11, a blower 14 is disposed as shown in FIG. 3. The blower 14 is comprised of a centrifugal multi-blade fan (sirocco fan) 15, a fan driving motor 16, and a scroll casing 17.

[0019]

A rotating shaft of the fan 15 is disposed to face in an approximately vertical direction (i.e., up-down direction of the vehicle), so that with the rotation of the fan 15, air that has been sucked in from the inside-outside air changeover box 11 through an unillustrated bell mouth-shaped suction port in the upper part of the scroll casing 17 is supplied in an approximately horizontal direction (i.e., from left to right of the passenger compartment B as seen from FIG. 1) towards an outlet of the scroll casing 17.

[0020]

On the other hand, an air-conditioning unit 2 having an air-conditioning heat exchanger is disposed approximately in the central part of the instrument panel P in the passenger compartment B. In the air-conditioning unit 2, an evaporator (i.e., cooling heat exchanger) 21 of a refrigeration cycle is disposed approximately horizontally, and air introduced from the blower 1 passes through the evaporator 21 from a lower side to an upper side thereof.

[0021]

Then, a heater core (i.e., heating heat exchanger) 22 is disposed approximately horizontally on a downstream air side of the evaporator 21 (i.e., upper side in the passenger compartment). The heater core 22 heats the blown-air by using the engine-cooling water (i.e., warm water) as a heat source. In the upper part (on the downstream air side) of the heater core 22 in the passenger compartment, a plurality of air passages are provided.

[0022]

That is, the air passages include a center face air passage 25, a side face air passage 26, a foot air passage 27, and a defroster air passage 28. The center face air passage 25 communicates with an unillustrated center face (upward) air vent at which air is blown out toward the head portion of a passenger in the passenger compartment. The side face air passage 26 similarly communicates with an unillustrated side face air vent.

[0023]

The foot air passage 27 communicates with an unillustrated foot air vent at which air is blown out towards the foot portion of the passenger in the passenger compartment. The defroster air passage 28 communicates with an unillustrated defroster vent at which the air is blown out towards a windshield of the vehicle.

In the air-conditioning unit 2, at the upper part of the heater core 22, there is provided an unillustrated built-in vent mode changeover portion which is operated by a door means (e.g., a plate-like door, a rotary door having a circular outer peripheral surface, a film-like door) to open and close the plurality of air passages 25, 26, 27 and 28. The plurality of air passages 25, 26, 27 and 28 are opened and closed by the door means of the vent mode changeover portion in order that a plurality of air outlet modes, such as a face mode, a bi-level mode, a foot mode, a defroster mode, and a foot/defroster vent mode, can be selected.

[0024]

In FIGS. 1, 2 and 3, the air passages are slightly modified. However, those are not major portions of the present invention and therefore differences thereof is not explained.

In the present example, a hot water control valve (not shown) is provided as air-conditioning temperature control means for controlling a flow rate of hot water flowing into the heater core 22. The flow rate of hot water flowing into the heater core 22 is thus controlled by the hot water control valve, thereby controlling the temperature of air being blown

into the passenger compartment by adjusting the amount of air heated by the heater core 22.

[0025]

FIG. 4 shows the constitution of the evaporator 21. The evaporator 21 is a laminated type in which the tubes 21f are laminated by anti-corrosive metal sheets such as aluminum sheets in a lateral direction (i.e., lamination direction) in the drawing. The evaporator includes a core portion 21h, and the core portion 21h is formed by the tubes 21f laminated to each other in the lamination direction and corrugated fins 21g arranged between adjacent tubes 21f. In the evaporator 21, air passing through the corrugated fins 21g is heat-exchanged with refrigerant flowing through the tubes so that air is cooled.

On both ends of the core portion 21h, there is arranged the tank portion 21e for distributing the refrigerant to the tubes 21f and for joining the refrigerant from the tubes 21f.

[0026]

FIG. 5 shows a disassembled structure of the air-conditioning apparatus in the present embodiment. As shown in FIG. 5, in the blower unit 1, a casing is a transverse separate type divided horizontally into three parts having dividing surface in a horizontal direction. That is, the casing is divided horizontally into the inside-outside air changeover box 11, the scroll casing 17, and an upper cover 17a of the casing 17. The upper cover 17a is provided with a bell-mouthed suction port 18 previously stated.

[0027]

The fan 15 of the blower 14 is integrally connected with a rotating shaft 16a of the motor 16, and then is disposed within the scroll casing 17. The motor 16 is attached to and fixed at a flange portion 16b to the scroll casing 17. Next, the upper cover 17a is attached to the upper end portion of the scroll casing 17; and the inside-outside air changeover box 11 is disposed above the bell-mouthed suction port 18 of the upper cover 17a, so that the upper cover 17a and the inside-outside air changeover box 11 are integrally assembled.

[0028]

On the other hand, in the air-conditioning unit 2, the casing is divided into three parts: two vertically separated left and right casings 23 and 24 each having a dividing surface in a vertical direction, and a cup-shaped lower casing 30. The evaporator 21, the heater core 22, and the air flow control door, etc. are mounted in either one of the two vertically separated casings 23 and 24 and then the other casing is connected to the one casing by known connecting means (e.g., metal spring clips, screws, etc.).

[0029]

In the air-conditioning unit 2, the evaporator 21 is supported on the inner wall surface of the lower casing 30 by a partition portion 33a and a drain guide plate 33b.

The inside-outside air changeover box 11, the scroll casing 17, the upper cover 17a, and the casings 23 and 24 are formed of a resin having a certain degree in elasticity, such

as the ABS resin.

[0030]

In the layout of the above-described air-conditioning unit 2, the evaporator 21 is arranged approximately horizontally and air is blown upwardly from below the evaporator 21. Therefore, air flows opposite to a fall direction of the condensed water; accordingly how to improve the draining efficiency of condensed water generated in the evaporator 21 will be a problem.

In the present embodiment, the following various considerations have been conducted in order to improve the draining efficiency of condensed water generated in the evaporator 21. That is, firstly, the evaporator 21 is arranged slightly inclined from the horizontal plane. That is, as shown in FIGS. 3 and 5, the evaporator 21 is disposed to be inclined downward by a little angle towards the forward side (to the right side in FIGS. 3 and 5) of flow of air being blown from the blower 14. Here, the inclination angle θ of the evaporator 21 is set within a range of 10 - 30 deg. (e.g., 18 deg. in the present example) to reduce the water capacity of the evaporator 21 itself.

[0031]

Secondly, each tube 21f of the evaporator 21 is arranged to extend in the same direction as the flow direction of air (i.e., in the direction from left side to right side in FIGS. 3 and 5). Thus, the condensed water is forced by the air flow to move smoothly on the surfaces of the tubes 21f towards the

inclined forward end (i.e., right-side end in FIGS. 3 and 5). Here, the condensed water generated on the evaporator is discharged, beneath of the evaporator 21 (on the upstream air side), through the condensed-water drain pipe 29 located at the lower end portion 32 of the inclined evaporator 21. The pipe 29 is integrally formed at a bottom portion of the lower casing 30 made of resin.

[0032]

Next, operation of the air-conditioning apparatus having the above-described constitution of the present embodiment will be explained.

In FIG. 3, air that has entered from the inside-outside air changeover box 11 is blown approximately horizontally by the fan 15 within the scroll casing 17, then flows into the lower part of the evaporator 21. Air is then directed upwardly and passes through the evaporator 21 to be dehumidified and to be cooled, and further flows upwardly into the heater core 22 where air is heated.

[0033]

In the case of the present example, the hot water control valve not depicted is employed as an air-conditioning temperature control means to control the quantity of hot water to be supplied to the heater core 22. That is, a flow control-reheat apparatus is adopted to gain a predetermined air temperature by controlling the flow rate of hot water by the hot water control valve. Air reheated to a predetermined temperature in the heater core 22 is distributed to a specific

air vent by the mode changeover portion disposed above the heater core 22.

[0034]

Next, the draining efficiency of condensed water generated on the evaporator 21, which is a major member of the present invention, will be now described. In the present example, a drain-improving portion 33 having a H-shaped cross-section is disposed in the lower casing 30 as shown in FIG. 5. Details of the drain-improving portion 33 will be shown in FIGS. 6 to 8.

FIG. 6 is an exploded view of the drain-improving portion 33 removed from the lower casing 30. FIG. 7 is a perspective view taken in the direction of the arrow A in FIG. 6, in which the drain-improving portion 33 and the evaporator 21 are disposed within the lower casing 30. FIG. 8 is a cross-sectional view taken along line B-B in FIG. 7, and FIG. 9 is a top view of the drain-improving portion 33 mounted in the lower casing 30 in FIG. 6.

[0035]

In the lower casing 30, the bottom surface 30a is formed to be inclined downwardly as shown in FIGS. 6 and 8. Thus, the condensed water that has dripped to the bottom surface 30a is collected to a part where the condensed-water drain pipe 29 is formed.

In the lower casing 30, a rail-like guide portion 34 is integrally formed to guide and support the drain-improving portion 33 as shown in FIG. 6. Furthermore, in the lower

casing 30, there is formed a boss 53 which is engaged with a screw 39 for fastening the drain-improving portion 33.

[0036]

The drain-improving portion 33 is made of a resinous material such as polypropylene. The drain-improving portion 33 includes the plate-like partition portion 33a (plate-like member), the plate-like drain guide plate 33b (the drain guide member), and a connecting portion 33c connecting the partition portion 33a and the drain guide plate 33b.

Each of the partition portion 33a and the drain guide plate 33b is formed to expand width thereof as they go towards the right side in FIGS. 6 and 8. Firstly, it is because the bottom surface 30a of the lower casing 30 is inclined downwardly and for the purpose that a lower end portion 35 of the partition portion 33a and a lower end portion 36 of the drain guide plate 33b will properly fit on the bottom surface 30a. Secondly, it is for the purpose that the upper end portion 37 of the partition portion 33a and the upper end portion 38 of the drain guide plate 33b will extend horizontally to contact the lower end portion 32 of the evaporator 21.

[0037]

The upper end portion 37 in the present example is made of elastomer rubber, forming an elastically deformable elastic portion 37 for partitioning. Also, the upper end portion 38 in the present example is made of elastomer rubber, forming an elastically deformable elastic portion 38 for discharging

water.

On the right-hand side of the lower end portion 35 of the partition portion 33a in FIG. 6, a semi-circular recess portion 42 is formed. Furthermore, on the right-hand side of the lower end portion 36 of the drain guide plate 33b in FIG. 6, a semi-circular recess portion 43 is formed.

[0038]

In the connecting portion 33c, a hole 40 is provided for the screw 39. Also, in the connecting portion 33c, a plurality of water drain holes 41 are formed in alignment with the hole 40 in a longitudinal direction of the connecting portion 33c. Then, after insertion of the partition portion 33a into the guide portion 34, the screw 39 is installed into the boss 53 through the hole 40, thereby fixedly attaching the drain-improving portion 33 into the lower casing 30.

[0039]

In the present example, though not shown in FIG. 6, an insulator 44 (shown in FIGS. 7, 8 and 9) which is a heat insulating material is disposed along the bottom surface 30a within the lower casing 30. Concretely, the insulator 44 is held between the drain-improving portion 33 and the bottom surface 30a as shown in FIGS. 7 and 8. The insulator 44 is not only disposed on the bottom surface 30a but extends upwardly along an inside wall surface of the lower casing 30 as shown in FIG. 7. Furthermore, the insulator 44 prevents dew formation on the outside surface of the lower casing 30 due to cooling operation of the evaporator 21.

[0040]

After the attachment of the drain-improving portion 33 in the lower casing 30 as described above, the evaporator 21 is disposed inside of the lower casing 30 in such a manner that the tank portion 21e of the evaporator 21 is positioned on the drain-improving portion 33 as shown in FIG. 7. That is, the evaporator 21 is disposed inside the lower casing 30 in such a manner that the tank portion 21e forms the lower end portion 32 of inclination.

[0041]

Thus, the upper end portion (elastic portion for partitioning) 37 and the upper end portion (elastic portion for draining) 38 are elastically deformed to contact the tank portion 21e of the evaporator 21. The partition portion 33a, as shown in FIG. 7, is disposed at an inclination upper end side of the evaporator 21 from the drain guide plate 33b. The partition portion 33a extends continuously to the entire width range of the evaporator 21 in a width direction perpendicular to both of an inclination direction from the upper end side towards the lower end side of the inclination of the evaporator 21 and a flow direction of air passing through the evaporator 21.

[0042]

In other words, the partition portion 33a continuously extends in an arrangement direction of the drain guide plate 33b in such a manner as to cover the drain guide plate 33b. The above-described arrangement direction is an extension

direction (i.e., the longitudinal direction of vehicle) of a single plate of the drain guide plate 33b. Also, for instance, when a plurality of drain guide plates 33b are disposed at spaces, the arrangement direction is meant by a direction of arrangement of the plurality of drain guide plates.

[0043]

When the evaporator 21 is arranged within the lower casing 30, the condensed water generated in the evaporator 21 flows from the inclined upper end side (i.e., left side in FIG. 7) of the evaporator 21 toward the inclined lower end side (right side in FIG. 7) of the evaporator 21; and therefore, the condensed water gathers at the lower end portion 32 of the evaporator 21. Thereafter, the condensed water drips to the bottom surface 30a of the lower casing 30 through the lower space 50 of the evaporator 21.

[0044]

The lower space 50 shown in FIG. 7 is provided under the evaporator 21, and is partitioned by the partition portion 33a into an air-blown space 50a where the air-conditioning air flows and a drain space 50b formed on a downstream side of the air-blown space 50a. Therefore, the condensed water gathering to the lower end portion 32 of the inclined evaporator 21 drops to the bottom surface 30a through the drain space 50b. In the drain space 50b, the drain guide plate 33b is disposed to be nearly contact (in full contact in the present example) the lower end portion 32 of the inclined evaporator 21.

[0045]

Next, behavior of the condensed water in the present example will be explained. The condensed water in the evaporator 21 is generated in the whole body of the evaporator 21; however, since the air-conditioning air flows upwardly, the condensed water cannot drop directly with the weight of its own, but will flow down along the surface (the surface which can contact the outside air) of the evaporator 21.

[0046]

Thereafter, when the mass of the condensed water gathering at the lower end portion 32 of the evaporator 21 has grown larger to a certain degree, the condensed water flows downwardly along the outside surface of the drain guide plate 33b shown at right side in FIG. 7, and repeats an intermittent downward draining motion. As a result, the condensed water running downwardly along the drain guide plate 33b reaches the bottom surface 30a of the lower casing 30 (actually, the upper surface of the insulator 44), then flows smoothly along the inclined bottom surface 30a and flows into the condensed water drain pipe 29 from which the condensed water is discharged to the outside of the passenger compartment.

[0047]

When the mass of the condensed water gathering at the lower end portion 32 of the evaporator 21 has grown to a certain amount, the condensed water flows also along the surface of the drain guide plate 33b on the left side in FIG. 7. The condensed water reaches the upper surface of the connecting plate 33c, flows downwardly into the drain hole 43,

and then reaches the bottom surface 30a located just between the partition portion 33a and the drain guide plate 33b. The condensed water flows along the inclination of the bottom surface 30a to the right side in FIGS. 7 and 8, then flows into the drain pipe 29 from the drain hole 43 to be discharged smoothly to the outside of the passenger compartment. Further, the condensed water going to the surface of the drain guide plate 33b on the left side in FIG. 7 can reach to the upper surface of the connecting plate 33c. Because the connecting plate 33c is inclined as shown in FIG. 8, the condensed water gathers to the lower end portion of inclination, thereafter dropping into the drain hole 41 located in the lowermost (on the right side) position in FIG. 8. Then, the condensed water runs to the right side in FIGS. 7 and 8 along the inclination of the bottom surface 30a, and then flows into the drain pipe 29 through the water drain hole 43 to be discharged smoothly to the outside of the passenger compartment.

[0048]

In the present example, the evaporator 21 is disposed in the lower casing 30 in such a manner that a part of the tank portion 21e forms the lower end portion; and therefore, the behavior of the condensed water differs greatly from that in the prior art air-conditioning apparatus. That is, it has been found by the investigation of the present inventors that since the tank portion 21e is complicated in outside shape as compared with the core portion 21h as shown in FIG. 4, the condensed water is hard to be collected at the lower end

portion 32 of the evaporator 21 to be hardly discharged, and is easy blown off like in prior art apparatus.

[0049]

In the present example, therefore, the lower space 50 is separated by the partition portion 33a into the blown-air space 50a and the drain space 33b, and the drain guide plate 33a is covered with the partition portion 33a formed by a single uninterrupted plate (i.e., a single plate). It is, therefore, possible to prevent the air-conditioning air flowing upwardly from hitting against the lower end portion 32 where the condensed water is gathered. Consequently, the condensed water that is rapidly gathered to the lower end portion 32 of the evaporator 21, entirely without being affected by the air-conditioning air, can be discharged by the drain guide plate 33b to drip to the bottom surface 30a. Therefore, condensed water draining efficiency can be improved.

[0050]

Also, in the present example, when the evaporator 21 is disposed within the lower casing 30, the elastic portion 37 elastically deforms to contact the tank portion 21e of the evaporator 21 and to seal therebetween. Therefore, it is possible to prevent the air-conditioning air from hitting against the lower end portion 32 of the evaporator 21. Consequently, the condensed water that has been gathered at the lower end portion 32 of the evaporator 21 can be discharged rapidly by the drain guide plate 33b, and easily drips to the bottom surface 30a to improve the condensed-water drain

efficiency.

[0051]

When the air-conditioning air pressure is little (i.e., the volume of the air-conditioning air is small), or when entirely no air-conditioning air flows, the condensed water may sometimes drip into the air-blown space 50a at the left side in FIG. 7. Even in this case also, the condensed water can be discharged sufficiency in the present example.

That is, the condensed water dripped into the air-blown space 50a drips to the bottom surface 30a of the lower casing 30. Because of the inclination of the bottom surface 30a, the condensed water flows to the right side in FIG. 9. Then the condensed water flows into the condensed-water drain pipe 29 through the recess portions 42 and 43. That is, the recess portions 42 and 43 and the bottom surface 30a (i.e., the upper surface of the insulator 44) form a drain passage 60 through which condensed water is introduced into the condensed-water drain pipe 29. The condensed water dripped to the air-blown space 50a is introduced into the drain space 50b through the drain passage 60. Therefore, the condensed water that has been dripped into the air-blown space 50a can also be discharged smoothly to the condensed-water drain pipe 29.

[0052]

The upper end portion 37 of the partition portion 33a (the elastic portion 37 for partitioning) is disposed to be proximate to a border (in the present example, near the tank portion 21e) between the core portion 21h of the evaporator 21

and the tank portion 21e; and therefore, it is possible to prevent the air-conditioning air from hitting against the tank portion 21e without reducing the volume of the air-conditioning air which passes through the core portion 21h. Thus, the condensed-water draining efficiency can be improved without decreasing the cooling capacity of the evaporator 21.

[0053]

Furthermore, according to the present invention, the drain guide plate 33b is not necessarily required to contact the tank portion 21e, and the provision of a clearance is allowed within a range in which the condensed water can drip sufficiency from the lower end portion 32 of the evaporator 21. In such a structure, however, the clearance may be increased because of an assembling error when the evaporator 21 is disposed in the lower casing 30, and a trouble that the condensed water can not be guided by the drain guide plate 33b to the bottom surface 30a may be caused.

[0054]

In the present example, therefore, the elastic portion 38 (i.e., upper end portion of the drain guide plate 33b) is formed in the drain guide plate 33b. The elastic portion 38 is elastically deformed to contact the tank portion 21e, thereby enabling sufficiently guiding the condensed water to the bottom surface 30a notwithstanding the assembling error of the evaporator 21 and the manufacturing tolerance of the evaporator 21 itself.

Further, in the present example, the elastic portion 37

for partitioning and the elastic portion 38 for draining are used as a base for supporting the evaporator 21. It is, therefore, possible to hold the evaporator 21 within the lower casing 30 by the elastic portion 37 for partitioning and the elastic portion 38 for draining notwithstanding the assembling error of the evaporator and the manufacturing tolerance of the evaporator 21 itself.

[0055]

Further, in the present invention, the partition plate 33a and the drain guide plate 33b may be separately formed. In this case, however, it becomes necessary to respectively assemble the partition portion 33a and the drain guide plate 33b to the lower casing 30, which deteriorates assembling efficiency. In the present example, for purpose of improving the assembling efficiency, therefore, the partition plate 33a and the drain guide plate 33b are integrally connected by the connecting portion 33c.

[0056]

(Another Embodiment)

In the above-described embodiment, the evaporator 21 is a laminated type, but it is noted that the type of the evaporator is not limited thereto and may be a so-called serpentine type with a multi-porous flat tube bent in a snake-like shape and combined with corrugated fins.

[0057]

Furthermore, in the above-described embodiment, the elastic portion 37 for partitioning and the elastic portion 38

for draining are formed; however, at least one of them is sufficient, or both of them may be dispensed with.

Also in the above-described embodiment, the drain-improving portion 33 is formed of resin, but the drain-improving portion 33 may be formed of an elastically deformable material such as rubber.

Further, in the above-described embodiment, the drain-improving portion 33 is formed separately from the lower casing. However, the partition plate 33a and the drain guide plate 33b may be formed integrally with the bottom surface 30a of the lower casing 30. In this case, it is necessary to separately form the elastic portion 37 for partitioning and the elastic portion 38 for draining.

[0058]

Furthermore, in the above-described embodiment, the elastic portion 37 for partitioning and the elastic portion 38 for draining are formed of an elastomer rubber, but upper end portions of the partition plate 33a and the drain guide plate 33b may be formed thin to be readily elastically deformed.

Further, in the above-described embodiment, air passes through the evaporator 21, after flowing from the inclination upper end side to an inclination lower end side of the evaporator 21. However, air may pass through the evaporator 21, after flowing from a face side to a back side of the paper in FIG. 7.

[0059]

Furthermore, in the above-described embodiment, the

evaporator 21 is disposed so that the tank portion 21e forms the lower end portion 32. The present invention, however, is applicable to an air-conditioning apparatus similar to an air-conditioning equipment having a single-tank type evaporator in which the tank portion 21e is disposed only at the upper end portion of an inclined evaporator. Furthermore, the present invention is applicable to an air-conditioning apparatus having a single-tank type evaporator in which the tank portion is disposed at the lower end portion of an inclined evaporator.

[0060]

Furthermore, in the above-described embodiment, a flow-control reheat apparatus in which a hot water control valve is used as the air-conditioning temperature control means to control the quantity of hot water to be supplied to the heater core 22 has been explained. The present invention is also applicable to an air mix apparatus in which an air mix damper is employed for controlling the air mixing ratio, that is, a ratio of mixture of hot air passing through the heater core 22 and cool air bypassing the heater core 22.

[0061]

Furthermore, in the above-described embodiment, the air-conditioning apparatus for a vehicle according to the present invention has been explained, but it should be noticed that the present invention is not limited thereto.

Furthermore, in the above-described first embodiment, the partition plate 33a is disposed to contact the evaporator 21 to divide the lower space 50 into two spaces: the air-blown space

50a and the drain space 50b; however, there may be provided a slight clearance therebetween.

[0062]

Furthermore, in the above-described embodiment, the drain guide plate 33a is disposed to contact the evaporator 21; however, there may be provided a slight clearance therebetween.

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a view showing an air-conditioning apparatus mounted on a vehicle in a preferred embodiment according to the present invention;

FIG. 2 is a view showing an air-conditioning apparatus mounted on a vehicle in the embodiment of the present invention;

FIG. 3 is a schematic view showing an entire constitution of the air-conditioning apparatus in the embodiment of the present invention;

FIG. 4 is a schematic view showing an evaporator in the embodiment of the present invention;

FIG. 5 is a disassembled view of the air-conditioning apparatus in the embodiment of the present invention;

FIG. 6 is a disassembled view of the air-conditioning apparatus according to the embodiment of the present invention;

FIG. 7 is a detail view showing a major portion of the drain-improving portion in the embodiment;

FIG. 8 is a cross-sectional view taken along line B-B in FIG. 7; and

FIG. 9 is a top view of FIG. 6.

[Explanation of Reference Numerals]

21 ... cooling heat exchanger; 30 ... lower casing; 30a ... bottom surface; 32 ... lower end portion; 33a ... partition plate; 50 ... lower space; 50a ... air-blown space; 50b ... drain space

[DOCUMENT NAME] ABSTRACT OF THE DISCLOSURE

[ABSTRACT]

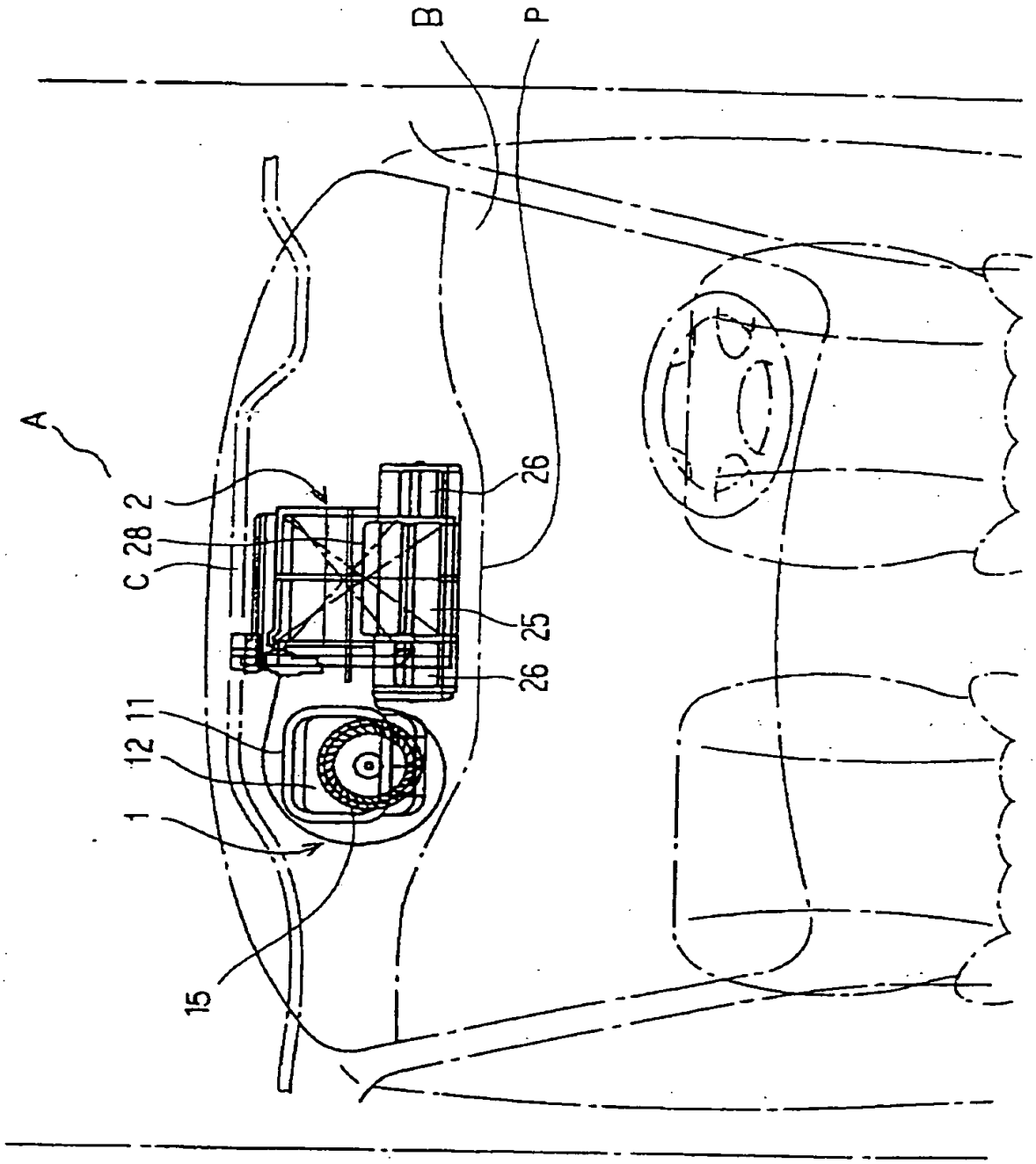
[Object] An object of the present invention is to provide an air-conditioning apparatus for a vehicle in which a cooling heat exchanger is inclined so that the fan air will flow upwardly through the cooling heat exchanger, thereby to improve the condensed-water draining efficiency of the cooling heater exchanger.

[Constitution] A lower space 50 is divided by a partition portion 33a into an air-blown space 50a and a drain space 50b, thereby preventing the air-conditioning air from hitting from below against a lower end portion 32 where the condensed water is gathered. Consequently, the condensed water that has been gathered at the lower end portion 32 of inclination of an evaporator 21 can be discharged rapidly along a drain guide plate 33b without being affected by the air-conditioning air, and drips to a bottom surface 30a. Thus, the condensed-water draining efficiency can be improved effectively.

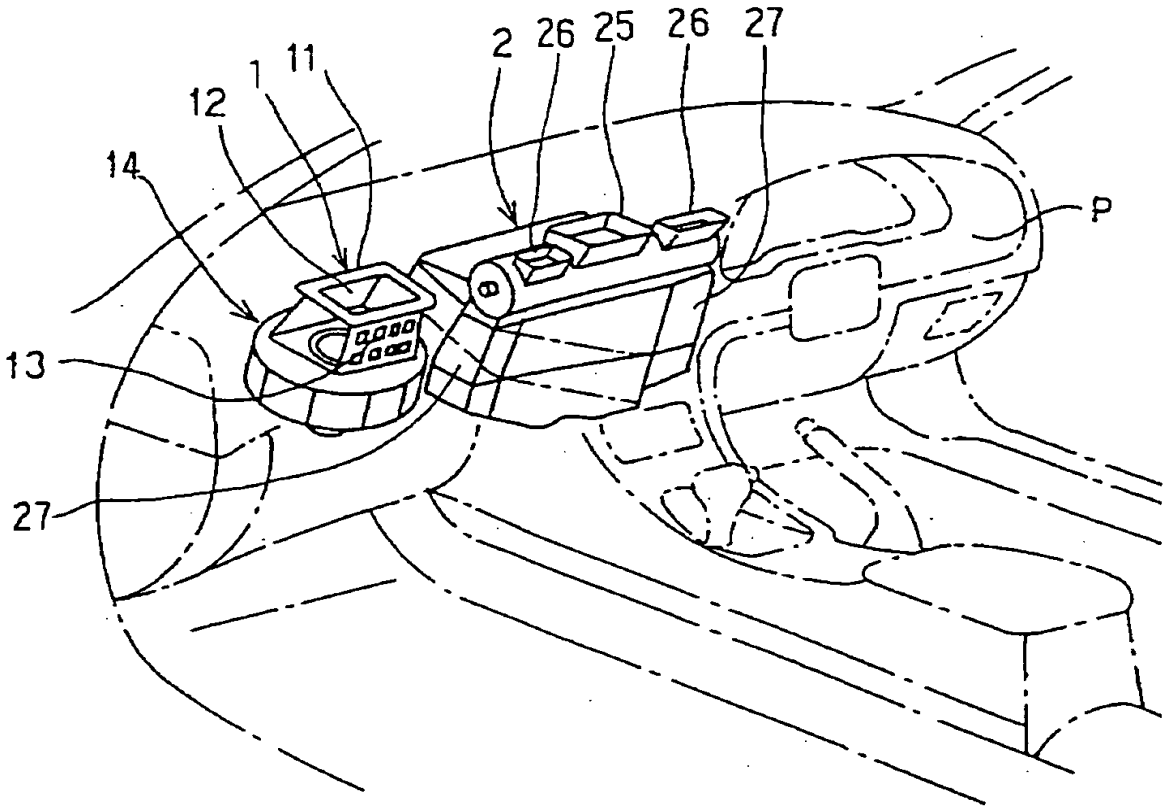
[SELECTED DRAWING] FIG. 7

【書類名】 図面 [Name of Document] Drawings

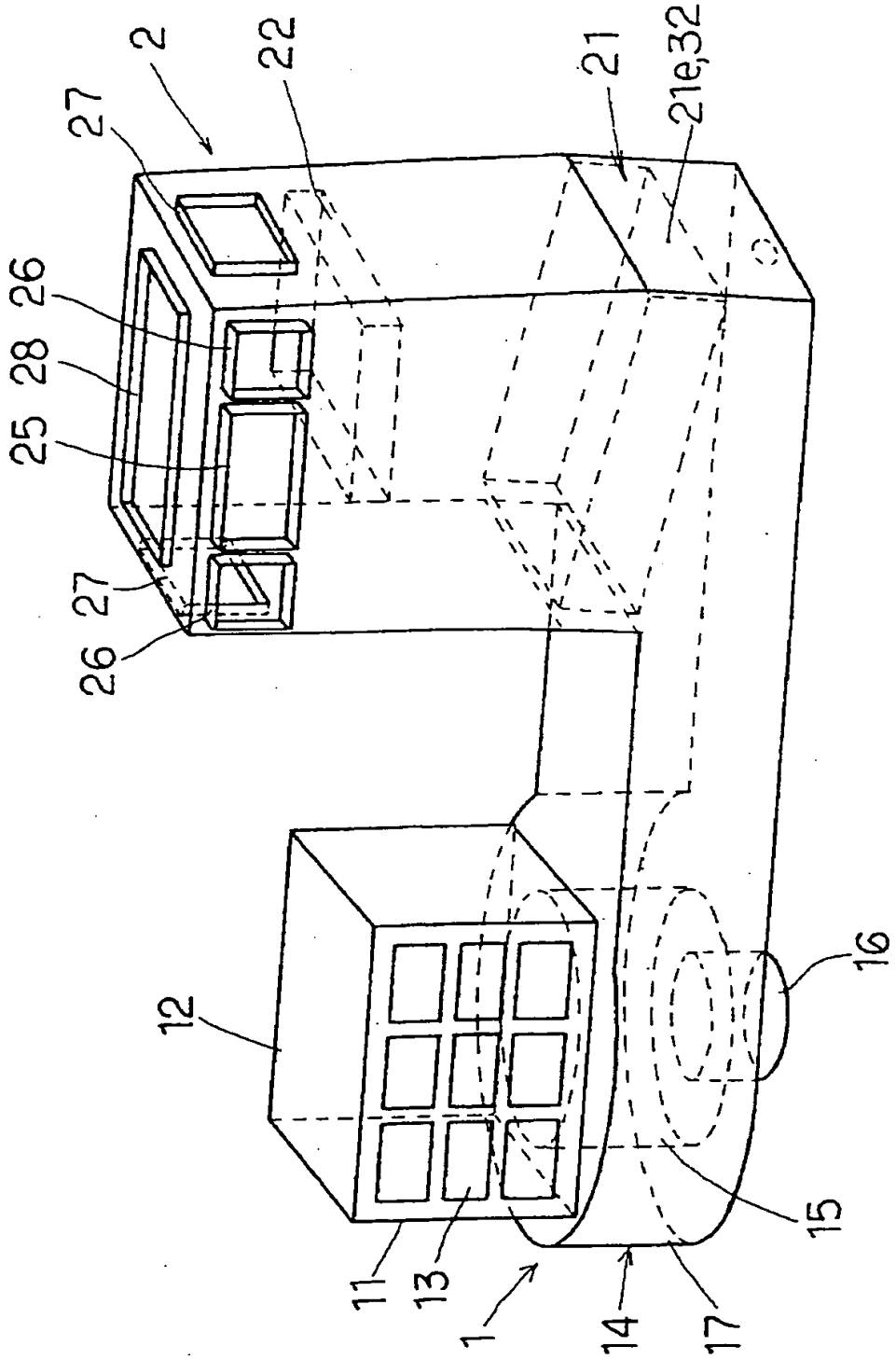
【図１】 [Fig. 1]



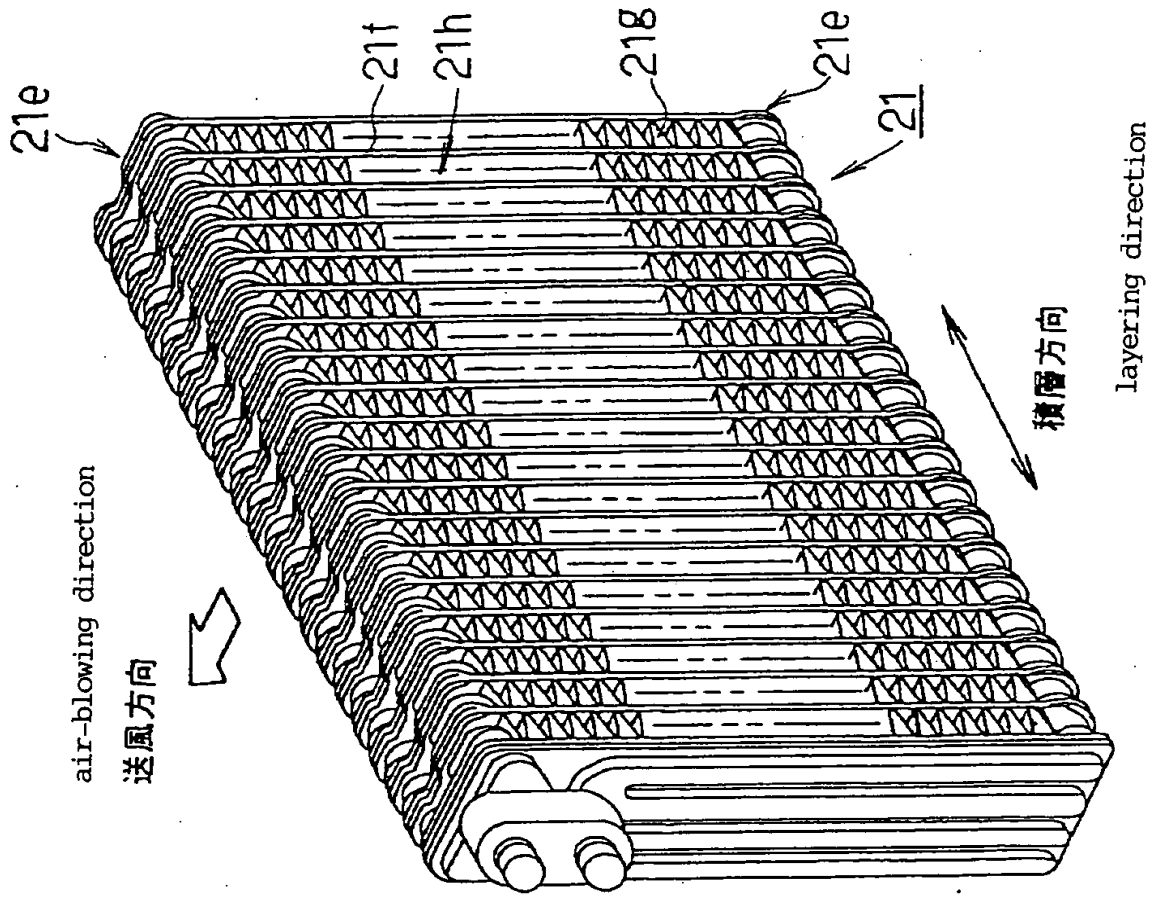
【図２】 [Fig. 2]



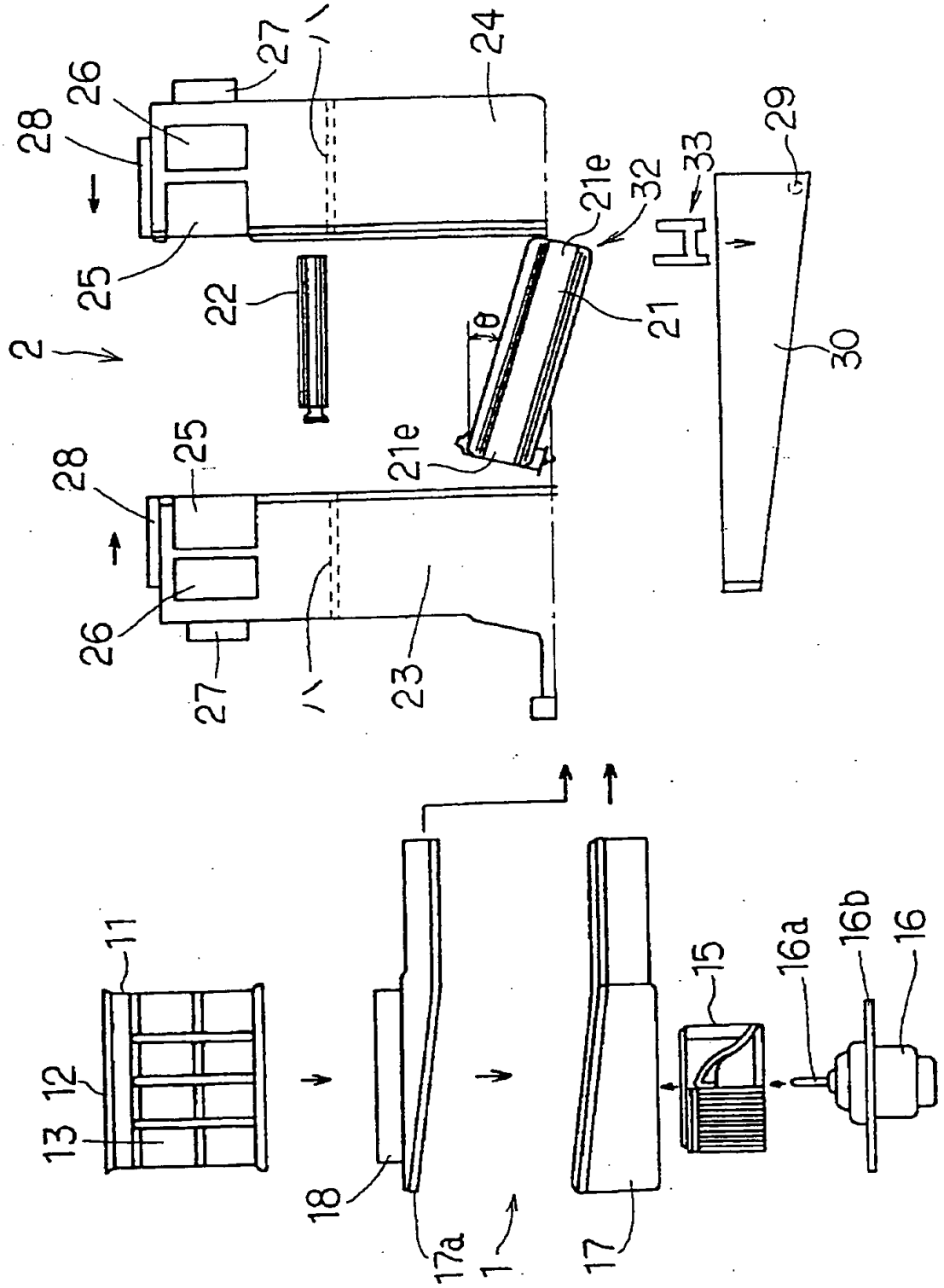
【図３】 [Fig. 3]



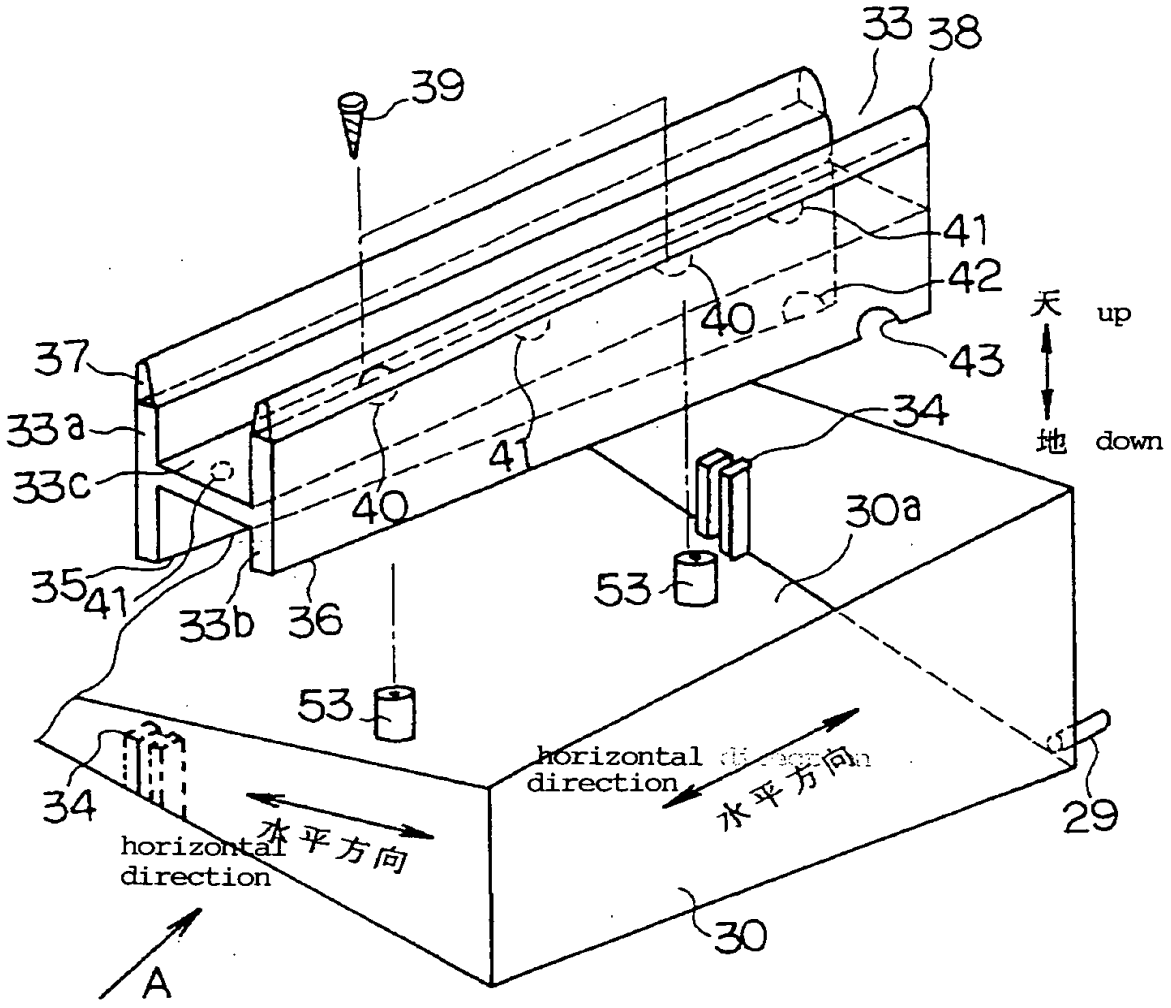
【図４】 [Fig. 4]


21e
21t
21h
21g
21e
21
積層方向
layering direction
air-blowing direction
送風方向

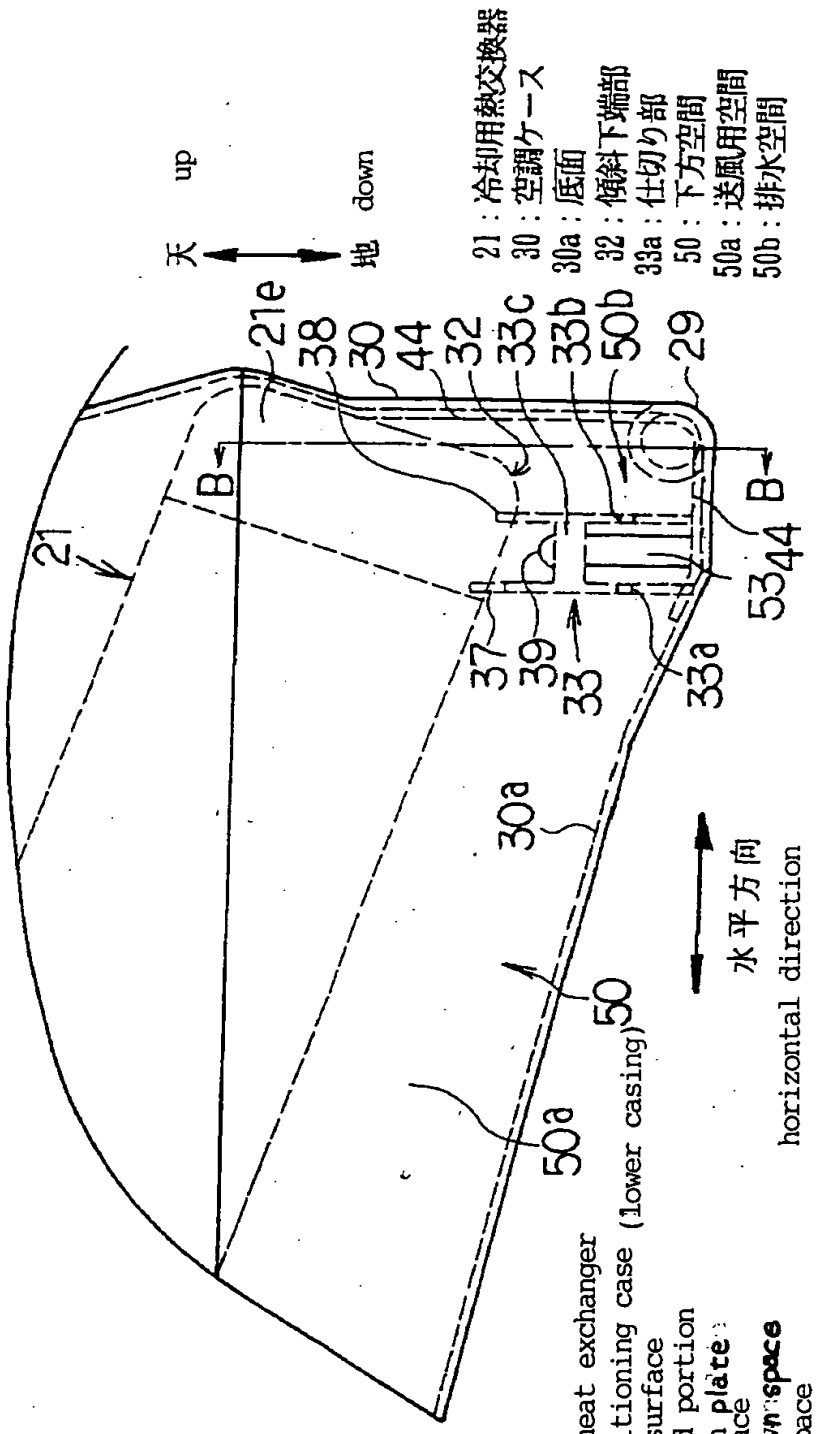
【図５】 [Fig. 5]


27
24
26
28
29
33
21e
32
25
22
21
θ
30
2
25
28
21e
26
27
23
11
12
13
18
15
16a
16b
16
17a
1
17

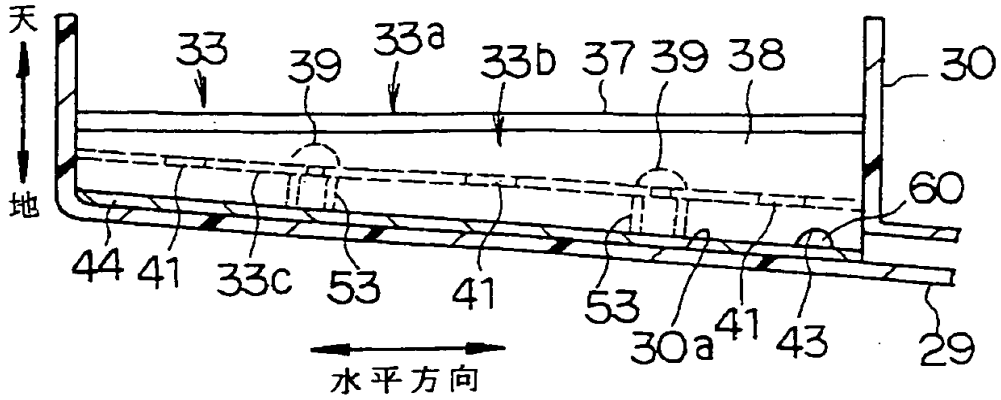
【図６】 [Fig. 6]


33
38
39
41
42
天 up
地 down
43
37
33a
33c
34
40
41
30a
35
41
33b
36
53
53
34
horizontal direction
水平方向
horizontal direction
水平方向
29
30
A

【図７】 [Fig. 7]


up
down
天
地
21e
38
30
44
32
33c
33b
50b
29
B
B
21
37
39
33
33a
53
44
30a
50
50a
水平方向
horizontal direction
21：冷却用熱交換器
30：空調ケース
30a：底面
32：傾斜下端部
33a：仕切り部
50：下方空間
50a：送風用空間
50b：排水空間
21. cooling heat exchanger
30. air-conditioning case (lower casing)
30a. bottom surface
32. lower end portion
33a. partition plate
50. lower space
50a. air-blown space
50b. drain space

【図８】 [Fig. 8]



【図９】 [Fig. 9]